University–industry linkages and academic engagements: individual behaviours and firms' barriers. Introduction to the special section

Article (Published Version)

J Technol Transf
DOI 10.1007/s10961-017-9576-x

University–industry linkages and academic engagements: individual behaviours and firms' barriers. Introduction to the special section

Andrea Filippetti[1,2] · **Maria Savona**[3,4]

Abstract The article introduces the special section on "University–industry linkages and academic engagements: Individual behaviours and firms' barriers". We first revisit the latest developments of the literature and policy interest on university–industry research. We then build upon the extant literature and unpack the concept of academic engagement by further exploring the heterogeneity of UI linkages along a set of dimensions and actors involved. These are: (1) Incentives and behaviours of individual academic entrepreneurs; (2) Firms' barriers to cooperation with public research institutions; (3) Individual behaviours, incentives and organizational bottlenecks in late developing countries. We summarize the individual contributions along these dimensions. There are overlooked individual characteristics that affect the degree of engagement of academics and scholars in cooperating with other organizations, of which gender and the non-academic background of individuals are most crucial. The notion of academic engagement should be enlarged to aspects that go beyond the commercialization or patenting of innovation, but embrace social and economic impact more at large. From the perspective of the firm, barriers to innovation might exert an effect on the likelihood to cooperate with universities and public research institutes, most especially to cope with lack of finance or access to frontier knowledge. We finally propose a research agenda that addresses the challenges ahead.

Keywords University–industry linkages · Academic engagement · Barriers to innovation

✉ Maria Savona
M.Savona@sussex.ac.uk

Andrea Filippetti
andrea.filippetti@cnr.it

[1] National Research Council of Italy, Rome, Italy

[2] London School of Economics, London, UK

[3] SPRU, University of Sussex, Jubilee Building, Falmer, Brighton BN1 9SL, UK

[4] Faculty of Economics and Social Sciences, University of Lille 1, Villeneuve-d'Ascq, France

Published online: 28 April 2017

JEL Classification O32 · O31

1 New trends and policy interest in university–industry research

It is widely recognized that universities and other public research institutions play a central role within systems of innovation for basic research generation, technology transfer and knowledge diffusion to firms (Archibugi and Filippetti 2017; Bercovitz and Feldman 2006; Hall et al. 2000; Mowery and Sampat 2005; Mowery and Shane 2002; Thursby and Thursby 2011). These processes are ensured by university–industry (UI) interactions, in their various modes (i.e. joint publications; joint research projects; co-patenting; spin-off), and their crucial role being recognized by both researchers and policy makers (Link and Scott 2005; Perkmann et al. 2013; Protogerou et al. 2013). Over the last ten years there has been a sizeable increase of the literature on the topic, while policymakers, are increasingly seeking the best handles to maximize the effectiveness of interactions between firms and public research institutions at the regional and national level.

Within this context, the policy debate revolving around academic entrepreneurship and innovation at the regional and local scale has been revamped, and a few aspects have emerged as crucial.

First, given the paramount importance of UI linkages for science and technology policy, contributions to the policy debate should consider that some scientific disciplines are more relevant for the industry than others, and this affects the links with industry that scientists in different fields have. While differences among scientific fields have long been recognized, only recently these differences have been more carefully discussed in relation to innovation and innovation policy (Cohen and Fjeld 2016; Nelson 2016; Whitley 2016). Recent empirical research has highlighted the different patterns of innovation resulting from the different scientific and knowledge base that characterize different sectors, as for instance in the case of the health sector and medical knowledge (Consoli et al. 2015; Consoli and Ramlogan 2008; Nelson et al. 2011). Also, science-based disciplines such as chemistry, behave differently from other disciplines in the exchanges between academia and industry (Hanel and St-Pierre 2006; Meyer-Krahmer and Schmoch 1998). By contrast, very little attention has been devoted to collaboration between university and industry in the humanities-related fields (see Gulbrandsen and Thune 2017). Importantly, differences among scientific disciplines have started to be taken into account also to inform policy (Gerbin and Drnovsek 2016; Gulbrandsen et al. 2011). There are also differences in the potential for commercialization depending on the area; for instance, research in the life sciences lends itself to commercial exploitation since fundamental research and applied work tend to co-evolve (Stephan and El-Ganainy 2007). Finally, an increasing number of studies have researched UI collaborations within a single sector, e.g. in the nanotechnologies (Leech and Scott 2017; Ponomariov 2013), pharmaceutical (Giunta et al. 2016), biotechnology (Thursby and Thursby 2011), chemistry (Kwiram et al. 1995) etc. Hence, studying the presence and importance of different patterns in UI linkages is crucial to design more suitable innovation policies.

Second, the role of geographical proximity has traditionally been considered the main determinant of UI interactions, smoothening institutional differences out (Ponds et al. 2007). This view is being complemented by one that also looks at non-geographical dimensions of proximity (such as organizational and institutional proximity), which in some cases emerge as having a larger impact than geographical proximity on the presence of cooperation (D'Este et al. 2012; Lindelöf and Löfsten 2004). Recognizing the importance of the local scale for knowledge diffusion and innovation, regional governments are

increasingly involved in policies aimed at creating technology-based economic development (Feldman and Choi 2015). Several initiatives have been taken in all European countries in order to strengthen the links between academia and industry, and to increase technology transfer efforts by academic institutions. However, evidence on the effectiveness of these initiatives is rather sketchy (Albats et al. 2017; e.g. Lerner 2009).

Recently published in Research Policy, the "Special Section on University–Industry Linkages: The Significance of Tacit Knowledge and the Role of Intermediaries" edited by Gulbrandsen et al. (2011) and the "Special Section on Heterogeneity and University–Industry Relations" (Kodama et al. 2008) have both focused on the traditional debate on UI linkages in advanced countries. A great deal of research has also analysed the role of university entrepreneurship, as in the Special Section on "University Entrepreneurship and Technology Transfer" published in *Management Science* (edited by Mowery and Shane 2002), which has focused on the technology transfer through licensing and university start-ups. All these contributions belong to the so-called "second-generation" stream of research that looked at the heterogeneity of UI linkages in terms of academic disciplines, types of universities and channels, research teams and individuals. A recent review (Perkmann et al. 2013) has put forward the concept of 'academic engagement', which refers to a broad range of activities, including collaborative research, contract research and consulting, which are carried out by an increasing number of academics. Academic engagement "represents inter-organisational collaboration instances, usually involving 'person-to-person interactions' that link universities and other organisations, notably firms" (p. 424). This shows that the boundaries of the potential modes of engagement of academics with the private sector are changing, and so it might be their effectiveness.

Finally, the interest has more recently extended to developing and transition countries, where the institutional contexts and the objectives for local development might be substantially different, and the need for evidence is all the more compelling (Albuquerque et al. 2015). For instance, in national systems of innovation that are at an infant phase, universities face the dual challenge of linking to global science, and of addressing local economic and social problems, which in the short run might be a different priority and a trade off with the desire to keep up with frontier knowledge. Understanding the drivers for academics and scientists, the barriers that firms and other actors might encounter and situating UI linkages in these contexts is thus critical to inform policy in developing economies.

It is therefore timely to reappraise how the current literature is developing, by building upon the more established and the recent debates on UI linkages. Here we aim to take stock of the most recent development of the literature, which has looked at how UI linkages are changing boundaries at the individual, firm, sectors and government levels, in both developed and late developing countries.

2 Aims and map of the special section

This special section includes a selected number of contributions to the workshops "University–Industry Linkages" held at *Roma Tre University* and "Scientific Labour Markets and Innovation Systems" held at the *Birkbeck Centre for Innovation Management Research, University of London*, in 2014 in addition to a few invited contributions from top scholars in the field. The two events have called for a better understanding of UI linkages and academic entrepreneurship in knowledge-based innovation systems.

The aim of this special section is to host those contributions that are able to build upon extant collections of studies and unpack the concept of academic engagement by further

exploring the heterogeneity of UI linkages along a different set of *dimensions* and *actors* involved. These are: (1) Incentives and behaviours of individual academic entrepreneurs; (2) Firms' incentives and barriers to cooperation with public research institutions; (3) Individual behaviours, incentives and organizational bottlenecks, idiosyncratic to late developing countries'.

2.1 Individual characteristics, proximities and academic engagement

First, the special section explores different characteristics of *individual behaviours*. Collaboration is by definition a social act, and besides personal preferences and circumstances, it will be shaped by gender, position in organisations, the nature and size of these organisations and the type of work individuals carry out. Besides individual characteristics, it is important to consider 'relational' influences, such as the closeness of individuals to each other in physical, organisational, social or other space, i.e. several types of proximities that go beyond the geographical one (Crescenzi et al. 2016; Tartari and Breschi 2012).

The individual nature of collaborations and individual drivers of academic entrepreneurship have been much overlooked within this literature (Etzkowitz et al. 2000). Rothaermel et al. (2007) noted that the literature on university entrepreneurship neglected the analysis of individual researchers' involvement in the process. Although since then the number of studies addressing individual interaction has increased significantly, as shown in Perkmann et al. (2013), most contributions have focused on personal characteristics such as sex, age, seniority, and academic standing of the scholar as drivers of academic entrepreneurship. However, less emphasis has been given to proximities, particularly those that differ from spatial ones, and to sociological aspects, such as social ties and the pro-social attitude of researchers, up until very recently (Iorio et al. 2017).

The paper by Crescenzi et al. (2017) addresses a number of fundamental research questions on UI collaborations. Are UI collaborations intrinsically different from other forms of collaboration, such as inter-firm or inter-university collaborations? Are they more difficult to set up? Is their output qualitatively different? What factors facilitate their development? By relying on a unique dataset that includes data on co-patenting not only between universities and companies, but also within the academy and the business sector, they look at UI linkages within a counter factual range of other collaborations. They find that UI collaborations are less likely to happen when compared to other types of collaboration, but that they tend to generate patents of more general applicability in subsequent inventions. Although they do not address explicitly the differences in scientific disciplines, their evidence raises the key question of whether differences across types of collaboration are attributable to the fact that UI collaborations tend to occur in some specific scientific disciplines compared to the other types of collaborations, namely those within the business sector.

An even less explored issue within the role of individual behaviours is that looking at the relevance of the gender gap. In fact, as Abreu and Grinevich (2016) explain, women academics are less likely to disclose their inventions, hold a patent, or create a new enterprise based on their research, even though the gender gap in other measures of academic productivity, such as publishing, is closing. By looking at the spin-off activity in UK universities and controlling for the difference in scientific disciplines, they find that one additional source of this gender gap depends on the fact that women academics are under-represented in both basic research, and over-represented in applied research, i.e. health sciences, social sciences, humanities and education. This is surely a line of research that would deserve more attention in the future, as we argue in the next section.

Gulbrandsen and Thune (2017) look at further, under-explored individual academics' characteristics in Norway: non-academic work experience. Recently, advice to policy makers has been recommending the recruitment of more academic personnel with non-academic work experiences to exploit their previous networks to establish contacts with the industry. However, this advice neglects individual and discipline-specific characteristics. In other words, to what extent would differences between academics with and without non-academic work experience vary by fields of science and types of non-academic work experience in terms of research performance? When asking this relevant question, Gulbrandsen and Thune find, among other interesting results, that the negative effects of non-academic work experience on research performance depend on the earlier sector of employment.

2.2 Individual characteristics and academic engagement in late developing countries

One of the main aims of this special section is addressing some of the gaps that have been identified in the relevant literature, such as the lack of cross-country comparative analysis and the excessive emphasis on Europe and the US (Perkmann et al. 2013), which makes the findings of this literature context-specific and therefore less generalizable to transition and developing countries (notable exceptions are provided by Fuentes and Dutrénit 2016; Malairaja and Zawdie 2008; Park and Leydesdorff 2010). The incentive structure, type of barriers and policies aimed at fostering interaction are likely to vary considerably across different countries. This special section values a comparative perspective and includes contributions based on different country cases, among which are several European countries (Germany, the Netherlands, Italy, France, Norway and the UK) as well as Latin America and South Africa.

For instance, the paper by Arza and Carattoli (2016) brings the key concept of social network ties (Granovetter 1973) into the personal characteristics that can affect different channels of U–I collaborations, in a late developing country such as Argentina. Measuring the strength of ties as a linear combination of friendship, trustworthiness, reciprocity of knowledge exchange and frequency of interaction, their evidence suggests that the strength of tie is associated with the probability of choosing different channels of interaction, and therefore conclude that the nature of personal relationship is relevant for the decision to commit time, knowledge and resources to long-term, demanding and risky interactions.

The interesting contribution by Kruss and Visser (2017) has a similar research objective, that of highlighting the idiosyncrasies of a late developing economy context that influence the effectiveness of UI linkages in favouring upgrading of an early innovation system such as the South African one. Based on primary sourced data from a survey conducted among South African individual academics, the original evidence shows that the heterogeneity of academic engagement and the emergence of barriers to UI linkages depend on two key elements. The first is a strong reputational control within universities as work organizations: academic engagement results from a variety of interactions with actors other than firms only and is constrained by a very hierarchical system within universities. The second, more general, is related to the priorities that universities as public organizations set within the national innovation system, with this affecting substantially the development of their 'academic identity'.

Overall, the main lesson stemming from these contributions on individual characteristics is that the latter do matter for UI linkages. This is therefore a promising area of

research that only lately is receiving attention. Individual characteristics, interacting with the territory, the type of scientific area involved, as well as with the previous non-academic work experience of researchers, shape UI-intensity collaboration in terms of intensity and nature. Regarding late developing countries, it seems that the nature of personal ties and the reputational control at the individual level within the interesting cases of Argentina and South Africa might represent a source of constraint to establish links between universities, public research institutes and the private sector at large. This is a relevant line of research that should be pursued further.

2.3 Barriers to innovation in firms as an incentive to cooperate

Finally, the special section revisits the large—seemingly larger than the one on individual behaviours—evidence on UI linkages at the firm level. The determinants of UI cooperation *at the firm level* have in fact long been explored, most especially in the innovation literature (Perkmann et al. 2013). However, the analyses of factors that slow down or hamper cooperation have been rather overlooked.[1] A few contributions included here shed light on this dimension, with relevant policy implications: while policy makers tend to focus more on the incentives to favour UI linkages, they oversee the issue of how to remove or attenuate the obstacles that hamper their establishment. Also, firms might establish cooperation with different private and public partners, such as universities and public research institutes, to alleviate the effects of barriers to innovation, in particular those related to knowledge accumulation and diffusion (Davey et al. 2016; D'Este et al. 2012, 2013; Hall et al. 2001; Pellegrino and Savona 2017) that might affect their innovation and economic performance (Coad et al. 2016). This special section hosts novel contributions that shed light on the nature of barriers to innovation and their specific effects when it comes to establishing cooperation with universities and public research institutes.

Guzzini and Iacobucci look at longitudinal German innovation data and, while confirming the largely established evidence that cooperation to innovation is associated with higher innovation performance of firms, also find that establishing cooperation with partners is more likely to be associated to delays in completing innovation projects, rather than a full failure (i.e. abandonment of them). However, interestingly, they also find that delayed projects are associated with higher innovation performance in terms of launch of new product and services. As far as the specific partners of cooperation are concerned they do not find any significant evidence that cooperation between firms and public research institutes is more likely to result in delayed, or indeed, abandoned projects than cooperation among private firms. These findings counterbalance anecdotal evidence that UI linkages might be comparatively more subject to coordination costs and therefore more doomed to fail than cooperation with the private sector.

Similarly, in comparing the nature of cooperation with public research institutes and private firms, specifically as a coping strategy and a way of mitigating the disruptive effect of barriers to innovation Antonioli, Marzucchi and Savona (2016) look at the presence and nature of barriers to innovation as a potential incentive to cooperate with different partners. Based on innovation data from France, they find that the perception of any barrier to innovation is indeed associated to a higher probability to cooperate *tout court* and that experiencing specific constraints is associated with the choice of specific partners, such as clients, competitors or universities. While financial barriers would spur cooperation with

[1] For some notable exceptions see: (Kanama and Nishikawa 2017; López-Martínez et al. 1994; Mora Valentín 2000).

any partner, the experience of lack of knowledge on technologies, or markets, or lack of human capital seems to lead firms to resort to public research institutes and universities—as one might expect. Interestingly, even a strategy of cost sharing in case of financial constraints seems to be similarly associated to UI linkages. This is however deterred when firms experience both knowledge and financial obstacles. The authors also look at whether experiencing one or several types of barriers has a super- or sub-modular effect on the likelihood to cooperate. The evidence suggests that while experiencing a single specific obstacle significantly raises the likelihood of cooperating with any type of partner, firms that experience several constraints to innovation are deterred from "sharing the pain" with cooperation partners.

3 The challenges ahead: a research agenda

The rationale of reviving the debate on UI linkages within a context of academic engagement and barriers to innovation attempts to address dimensions that are overlooked in the extant, albeit large and established, literature. These are: first, the role of individual characteristics, behaviour, incentives and constraints to engage in cooperation with other actors, most importantly the private sector, but also other actors within the innovation system; second, the specificities of both individual behaviours and organizational constraints in late developing contexts, with this latter evidence importantly contributing to the formulation of systematic and systemic innovation policies to foster advances in basic and applied research; third, the role of barriers and constraints to innovation in affecting cooperation between firms and public research institutes, from the perspective of firms and public organizations.

Several novel aspects have emerged that contribute to reviving the debate on academic entrepreneurship and the innovation system literature. There are overlooked individual characteristics that affect the degree of engagement of academics and scholars in cooperating with other organizations, of which gender and the non-academic background of individuals are most crucial. The notion of academic engagement should be usefully enlarged to aspects that go beyond the commercialization or patenting of innovation, but embrace social and economic impact more at large. Beyond the individual, and most especially in late industrializing countries such as in the cases of Argentina and South Africa hosted here, what matters is also a dense network of social ties, and the specific identity and reputational characteristics of the academic organization. These characteristics represent more of a bottleneck than an incentive to engage in cooperation with other institutions.

From the perspective of the firm, the evidence hosted here has highlighted that barriers to innovation might exert an effect on the likelihood to cooperate with other partners, most especially to cope with lack of finance or access to frontier knowledge. On the other hand, it is suggested that UI linkages, contrary to anecdotal evidence, are not doomed to fail more often than other types of cooperation among actors.

Within this context, future research should explore the presence of systematic differences across fields of science. While previous research has highlighted the relative higher importance of UI linkages for some specific fields, as for instance medical research and engineering, our special section shows that there are collaborations taking place also in other scientific disciplines. A potential gap to be addressed relates to the relative importance of other scientific disciplines, both in the hard science and in the humanities, in UI

collaboration in the first place. To the extent that different disciplines require different types and frequency of interaction between academic researchers and those in the private sectors, personal traits and individual incentives, such as those discussed in some contributions here, might have a systematically different effect across sciences.

The role of the territorial proximity, a widely studied issue here and elsewhere, can also vary depending on the knowledge and technology involved in the collaboration activity. The role of spatially mediated knowledge externalities for UI linkages that have emerged clearly in fields, such as engineering (e.g. D'Este et al. 2013), might appear as less relevant in other scientific fields. Future research should therefore delve into what type of proximity (e.g. spatial, institutional, organizational, etc.) would play a role across different scientific domains. This analysis would inform policy learning to a great extent.

This is also relevant for future research about late developing countries along the lines touched upon in the two contributions hosted here, to the extent that these countries tend to differ in terms of technological specialization.

For what concerns future research on obstacles on UI linkages, the contributions in this special section have only started to uncover some of their aspects, such as the rates of failure of joint projects and the presence of higher coordination costs. Once again, bottlenecks and hampering factors that ensue from adversity to risk and cost sharing, or lack of frontier knowledge that would benefit from cooperation is very discipline-specific. Further research should go more in depth on barriers to innovation in specific fields of research.

Finally, science, technology and innovation policy can play a crucial role to foster UI linkages, as hinted throughout this special section. First and foremost, the evidence reported here reinforces the idea that there is no such a thing as a single *one-type-fits-all* or *best-practice* policy to encourage joint research between the public research sector and the business sector. Differences have arisen regarding the role of personal traits of the researchers, both in academia and in the private companies, the relative importance of these traits in developed vis-à-vis late developed countries, which are deemed to be intertwined with the different scientific disciplines and knowledge which in turn reflect the different technological and industrial specialization of the regions and countries. The view of policies that need to be *smart* (or place-based) and unpacked at the local level, seems also to apply also to the case of UI linkages types of policy (McCann and Ortega-Argilés 2013; Barca et al. 2012). By restating the need to address the considerable amount of heterogeneity that characterize the patterns of UI collaborations, this special section does not make life easier for policy makers, but it might avoid future policy failure and waste of public money.

In summary, the contributions hosted in this special section provide a substantial richness of evidence across country and across levels of analysis, but also suggest directions for a more substantial research effort on individual behaviours and barriers to innovation, while extending these also to a higher number of developing contexts that might have a range of heterogeneity in the institutional constraints.

Acknowledgements The Guest Editors are profoundly indebted to Richard R. Nelson (Earth Institute, Columbia University, US), who greatly contributed to earlier versions of this article, by providing precious and timely suggestions and remarks. The Guest Editors wish to thank all the contributors and the Editor in Chief of the Journal of Technology Transfer, Al Link, for the effective and timely support. They also wish to warmly thank all the referees that have provided thorough suggestions and remarks to the contributors. Also, they also want to express their gratitude to Anna Giunta (Roma Tre University, Italy), Frederick Guy and Helen Lawton-Smith (Birkbeck Centre for Innovation Management Research, University of London, UK),

and Simona Iammarino (London School of Economics and Political Science, UK) for the organization of the two workshops that have inspired this Special section.

References

Abreu, M., & Grinevich, V. (2016). Gender patterns in academic entrepreneurship. *The Journal of Technology Transfer*. doi:10.1007/s10961-016-9543-y.

Albats, E., Fiegenbaum, I., & Cunningham, J. A. (2017). A micro level study of university industry collaborative lifecycle key performance indicators. *The Journal of Technology Transfer*, 1–43.

Albuquerque, E., Suzigan, W., Kruss, G. & Lee, K. (2015). *Developing national systems of innovation: University–industry interactions in the global south.* Cheltenham: Edward Elgar Publishing.

Antonioli, D., Marzucchi, A., & Savona, M. (2016). Pain shared, pain halved? Cooperation as a coping strategy for innovation barriers. *The Journal of Technology Transfer*. doi:10.1007/s10961-016-9545-9.

Archibugi, D., & Filippetti, A. (2017). The retreat of public research and its adverse consequences on innovation. *Technological Forecasting and Social Change* (forthcoming).

Arza, V., & Carattoli, M. (2016). Personal ties in university-industry linkages: A case-study from Argentina. *The Journal of Technology Transfer*. doi:10.1007/s10961-016-9544-x.

Barca, F., McCann, P., & Rodríguez-Pose, A. (2012). The case for regional development intervention: Place-based versus place-neutral approaches. *Journal of Regional Science, 52,* 134–152.

Bercovitz, J., & Feldman, M. (2006). Entprepreneriel universities and technology transfer: A conceptual framework for understanding knowledge-based economic development. *The Journal of Technology Transfer, 31,* 175–188.

Coad, A., Pellegrino, G., & Savona, M. (2016). Barriers to innovation and firm productivity. *Economics of Innovation and New Technology, 25*(3), 321–334.

Cohen, W. M., & Fjeld, J. (2016). The three legs of a stool: Comment on Richard Nelson, "The sciences are different and the differences matter". *Research Policy, 45,* 1708–1712.

Consoli, D., Mina, A., Nelson, R. R., & Ramlogan, R. (2015). *Medical innovation: Science, technology and practice*. London: Routledge.

Consoli, D., & Ramlogan, R. (2008). Out of sight: Problem sequences and epistemic boundaries of medical know-how on glaucoma. *Journal of Evolutionary Economics, 18,* 31–56.

Crescenzi, R., Filippetti, A., & Iammarino, S. (2017). Academic inventors: Collaboration and proximity with industry. *The Journal of Technology Transfer*. doi:10.1007/s10961-016-9550-z.

Crescenzi, R., Nathan, M., & Rodríguez-Pose, A. (2016). Do inventors talk to strangers? On proximity and collaborative knowledge creation. *Research Policy, 45,* 177–194.

Davey, T., Rossano, S., & van der Sijde, P. (2016). Does context matter in academic entrepreneurship? The role of barriers and drivers in the regional and national context. *The Journal of Technology Transfer, 41,* 1457–1482.

D'Este, P., Guy, F., & Iammarino, S. (2013). Shaping the formation of university–industry research collaborations: What type of proximity does really matter? *Journal of Economic Geography, 13,* 537–558.

D'Este, P., Iammarino, S., Savona, M., & von Tunzelmann, N. (2012). What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy, 41*(2), 481–488.

Etzkowitz, H., Webster, A., Gebhardt, C., & Terra, B. R. C. (2000). The future of the university and the university of the future: Evolution of ivory tower to entrepreneurial paradigm. *Research Policy, 29,* 313–330.

Feldman, M. P., & Choi, J. (2015). Harnessing the geography of innovation. In D. Archibugiand & A. Filippetti (Eds.), *The handbook of global science, technology, and innovation* (Chap. 13, pp. 267–289). John Wiley & Sons, Ltd.

Fuentes, C. D., & Dutrénit, G. (2016). Geographic proximity and university–industry interaction: The case of Mexico. *The Journal of Technology Transfer, 41,* 329–348.

Gerbin, A., & Drnovsek, M. (2016). Determinants and public policy implications of academic-industry knowledge transfer in life sciences: A review and a conceptual framework. *The Journal of Technology Transfer, 41,* 979–1076.

Giunta, A., Pericoli, F. M., & Pierucci, E. (2016). University–industry collaboration in the biopharmaceuticals: The Italian case. *The Journal of Technology Transfer, 41,* 818–840.
Granovetter, M. S. (1973). The strength of weak ties. *American Journal of Sociology*, *78*(6), 1360–1380.
Gulbrandsen, M., Mowery, D., & Feldman, M. (2011). Introduction to the special section: Heterogeneity and university–industry relations. *Research Policy, 40,* 1–5.
Gulbrandsen, M., & Thune, T. (2017). The effects of non-academic work experience on external interaction and research performance. *The Journal of Technology Transfer*. doi:10.1007/s10961-017-9556-1.
Hall, B. H., Link, A. N., & Scott, J. T. (2000). *Universities as Research Partners*. National Bureau of Economic Research.
Hall, B. H., Link, A. N., & Scott, J. T. (2001). Barriers inhibiting industry from partnering with universities: Evidence from the advanced technology program. *The Journal of Technology Transfer, 26,* 87–98.
Hanel, P., & St-Pierre, M. (2006). Industry–university collaboration by Canadian manufacturing firms. *The Journal of Technology Transfer, 31,* 485–499.
Iorio, R., Labory, S., & Rentocchini, F. (2017). The importance of pro-social behaviour for the breadth and depth of knowledge transfer activities: An analysis of Italian academic scientists. *Research Policy*, *46*(2), 497–509. doi:10.1016/j.respol.2016.12.003.
Kanama, D., & Nishikawa, K. (2017). What type of obstacles in innovation activities make firms access university knowledge? An empirical study of the use of university knowledge on innovation outcomes. *The Journal of Technology Transfer, 42,* 141–157.
Kodama, F., Yusuf, S., & Nabeshima, K. (2008). Introduction to special section on university–industry linkages: The significance of tacit knowledge and the role of intermediaries. *Research Policy, 37,* 1165–1166.
Kruss, G., & Visser, M. (2017). Putting university–industry interaction into perspective: A differentiated view from inside South African universities. *The Journal of Technology Transfer*. doi:10.1007/s10961-016-9548-6.
Kwiram, A. L., Koch, M., Paden, J. E., & Halldorson, B. M. (1995). University–industry consortium agreements center for process analytical chemistry: A case study. *The Journal of Technology Transfer, 20,* 45–55.
Leech, D. P., & Scott, J. T. (2017). Nanotechnology documentary standards. *The Journal of Technology Transfer, 42,* 78–97.
Lerner, J. (2009). *Boulevard of broken dreams: Why public efforts to boost entrepreneurship and venture capital have failed—and what to do about it*. Princeton, NJ: Princeton University Press.
Lindelöf, P., & Löfsten, H. (2004). Proximity as a resource base for competitive advantage: University–industry links for technology transfer. *The Journal of Technology Transfer, 29,* 311–326.
Link, A. N., & Scott, J. T. (2005). Opening the ivory tower's door: An analysis of the determinants of the formation of us university spin-off companies. *Research Policy, 34,* 1106–1112.
López-Martínez, R. E., Medellín, E., Scanlon, A. P., & Solleiro, J. L. (1994). Motivations and obstacles to university industry cooperation (UIC): A Mexican case. *R&D Management, 24,* 017–030.
Malairaja, C., & Zawdie, G. (2008). Science parks and university–industry collaboration in Malaysia. *Technology Analysis & Strategic Management, 20,* 727–739.
McCann, P., & Ortega-Argilés, R. (2013). Smart specialization, regional growth and applications to European Union cohesion policy. *Regional Studies*, *49*, 1–12.
Meyer-Krahmer, F., & Schmoch, U. (1998). Science-based technologies: University–industry interactions in four fields. *Research Policy, 27,* 835–851.
Mora Valentín, E. M. (2000). University–industry cooperation: A framework of benefits and obstacles. *Industry and Higher Education, 14,* 165–172.
Mowery, D. C., & Sampat, B. N. (2005). Universities in national innovation systems. In J. Fagerberg, D. C. Mowery, & R. Nelson (Eds.), *The Oxford handbook of innovation*. Oxford: Oxford University Press.
Mowery, D. C., & Shane, S. (2002). Introduction to the special issue on university entrepreneurship and technology transfer. *Management Science, 48,* v–ix.
Nelson, R. R. (2016). The sciences are different and the differences matter. *Research Policy, 45,* 1692–1701.
Nelson, R. R., Buterbaugh, K., Perl, M., & Gelijns, A. (2011). How medical know-how progresses. *Research Policy, 40,* 1339–1344.
Park, H. W., & Leydesdorff, L. (2010). Longitudinal trends in networks of university–industry—government relations in South Korea: The role of programmatic incentives. *Research Policy, 39,* 640–649.
Pellegrino, G., & Savona, M. (2017). No money, no honey? Financial versus knowledge and demand constraints on innovation. *Research Policy*, *46*(2), 510–521.
Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., et al. (2013). Academic engagement and commercialisation: A review of the literature on university–industry relations. *Research Policy, 42,* 423–442.

Ponds, R., Van Oort, F., & Frenken, K. (2007). The geographical and institutional proximity of research collaboration. *Papers in Regional Science, 86,* 423–443.

Ponomariov, B. (2013). Government-sponsored university–industry collaboration and the production of nanotechnology patents in US universities. *The Journal of Technology Transfer, 38,* 749–767.

Protogerou, A., Caloghirou, Y., & Siokas, E. (2013). Twenty-five years of science-industry collaboration: The emergence and evolution of policy-driven research networks across Europe. *The Journal of Technology Transfer, 38,* 873–895.

Rothaermel, F. T., Agung, S. D., & Jiang, L. (2007). University entrepreneurship: A taxonomy of the literature. *Industrial and Corporate Change*, *16*(4), 691–791. doi:10.1093/icc/dtm023.

Stephan, P. E., & El-Ganainy, A. (2007). The entrepreneurial puzzle: Explaining the gender gap. *The Journal of Technology Transfer, 32,* 475–487.

Tartari, V., & Breschi, S. (2012). Set them free: Scientists' evaluations of the benefits and costs of university–industry research collaboration. *Industrial and Corporate Change, 21,* 1117–1147.

Thursby, J., & Thursby, M. (2011). University–industry linkages in nanotechnology and biotechnology: Evidence on collaborative patterns for new methods of inventing. *The Journal of Technology Transfer, 36,* 605–623.

Whitley, R. (2016). Varieties of scientific knowledge and their contributions to dealing with policy problems: A response to Richard Nelson's "The sciences are different and the differences matter". *Research Policy, 45,* 1702–1707.